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(54) **Pest control**

(57) Sheep ectoparasites including lice, keds, flies, mites and ticks are controlled by the localised application to the skin or fleece of the sheep of a pyrethroid. The treatment is effective even on long-woolled Merino sheep.

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Certain of the chemical formulae appearing in the printed specification were submitted after the date of filing, the formulae originally submitted being incapable of being satisfactorily reproduced.

SPECIFICATION

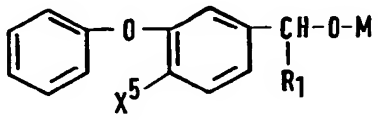
P st Control

The present invention relates to a method of controlling sheep ectoparasites including keds, lice, flies, mites and ticks. The invention has special application to the cntrol of the sheep-biting louse (Damalinia ovis) and keds (Melophagus ovinus) particularly on merino sheep.

Traditionally, sheep have been treated for the control of ectoparasites by dipping or spraying the whole external surface of the sheep. However, this is an inconvenient and time-consuming operation. Attempts have been made to treat infested sheep, particularly lice-infested sheep, with a large variety of known insecticides by various more conventional routes, including pour-on treatments, sub-cutaneous injection, and by oral dosage. Hitherto, none of the treatments had any significant effect on the control of the lice populations. In particular, merino sheep which have very dense wool have not responded to such treatments.

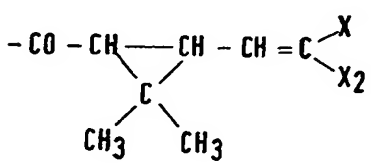
The present invention is based on the unexpected discovery that localised applications of pyrethroids are surprisingly effective in controlling and eradicating lice, keds, blow flies and other ectoparasites. It is particularly surprising that such localised application is effective even on long-wooled merino sheep.

Thus, the present invention provides a method of controlling sheep ectoparasites which comprises the application onto a localised region of the skin or fleece of a sheep of a pyrethroid of the formula.



wherein

M is



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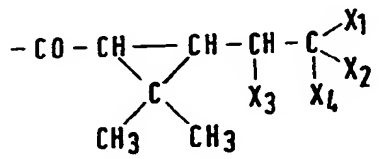
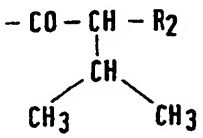




and wherein

X_1 to X_4 are independently selected from halo, C_1—C_4 alkyl, halogen-substituted C_1—C_4 alkyl, and halogen-substituted phenyl;

X_5 is —H or halo;

R_1 is —H or cyano; and

R_2 is halogen-substituted phenyl.

By "localised application" is meant that the pyrethroid is only applied to a minor portion of the skin or fleece of the sheep, generally as a line or spot on the sheep's back. It has been surprisingly discovered that, notwithstanding the presence of a sometimes dense coating of wool, the pyrethroid appears to act over the entire surface of the sheep. It is believed as a hypothesis that the pyrethroid is transmitted over the surface of the sheep by diffusion through the wool grease.

The pyrethroid is generally applied as a liquid formulation, a paste or as a solid powder. Surprisingly, it has been found that it is not necessary that the pyrethroid be dissolved to be effective.

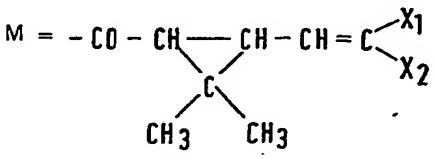
The localised application is preferably carried out as a pour-on treatment by pouring a liquid formulation comprising the pyrethroid along the back of the sheep (i.e. a so-called "backline" application). Surprisingly, it is not necessary to totally immerse the sheep in the formulation so that the treatment of large numbers of sheep is facilitated.

Alternatively, the application may be carried out by means of a localised spray or aerosol, usually along the sheep's back as it passes through a sheep race. The aerosol might comprise the pyrethroid dissolved in a liquid carbon dioxide propellant.

Without wishing to be limited by any theoretical mode of action, it is believed that the pyrethroid acts superficially and is not dermally and systemically absorbed. It is therefore surprising that protection over the entire sheep is attainable from a localised application.

The pyrethroid is preferably selected from the group of light stable pyrethroids. Deltamethrin (also known as d camethrin is preferred and is a solid under normal conditions. Suitable pyrethroids are disclosed in Tables I to III.

TABLE I



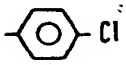
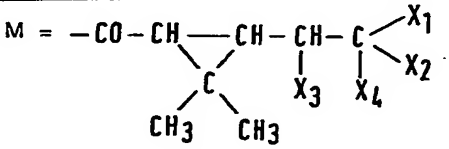
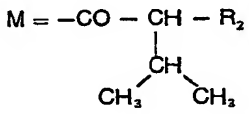
No.	X_1	X_2	X_3	X_4	X_5	R_1	trivial name
1	Cl	Cl	–	–	H	H	permethrin
2	CH_3	CH_3	–	–	H	H	phenothrin
3	Br	Br	–	–	H	CN	deltamethrin
4	Cl	Cl	–	–	H	CN	cypermethrin
5	Cl	CF_3	–	–	H	CN	cyhalothrin
6	Cl		–	–	F	CN	flumethrin
7	Cl	Cl	–	–	F	CN	cyfluthrin
8	CH_3	CH_3	–	–	H	CN	cyphenothrin

TABLE II



No.	X_1	X_2	X_3	X_4	X_5	R_1	trivial name
9	Br	Br	Br	Br	H	CN	tralomethrin
10	Cl	Cl	Br	Br	H	CN	tralocythrin

TABLE III



No.	R_2	X_5	R_1	trivial name
11		H	CN	fenvalerate

It is a particular advantage of the present m thod that only small volumes of pyrethroid or pyrethroid-containing formula need to be applied. Depending on the size of the sheep, the volume applied will generally lie in the range 2 to 15 ml p r sheep. For convenienc , the pyrethroid will generally be applied in a liquid formulation.

Depending on the efficacy of the particular pyrethroid employed, the formulation generally contains from 0.1 to 500, preferably 1 to 250 mg/ml of the pyrethroid. Moreover, the pyrehroid is preferably applied to the sheep in an application of from 1 to 500, preferably 1.5 to 250 mg/kg body weight.

The formulation may be applied to full-woolled or sheared sheep. However, higher doses are required for full-woolled sheep.

The pyrethroid is preferably applied in the form of a pour-on formulation. The formulation may comprise one or more organic solvents, such as xylene, toluene, cyclohexanone, and a glycol.

One preferred solvent system comprises 30—70 wt % xylene, 20—40 wt % cyclohexanone and 5—25 wt % vegetable oil.

Suitable glycols include ethylene glycol and propylene glycol, polyethylene glycols and polypropylene glycols, ethylene glycol-propylene glycol copolymers, and alkyl ethers and alkyl ether esters of the general formula:

$$R^2O—(CH_2—\underset{\displaystyle R^1}{\underset{|}{C}}HO)_n—CO—R^3$$

where

$R^1 = C_1$ alkyl or hydrogen,
$R^2 = C_1—C_5$ alkyl, hydrogen or —CO—R^3,
$R^3 = C_1—C_{12}$ alkyl, and
$n = 1—40$.

Diethylene glycol mono-n-butyl ether has been found to be particularly useful. It has been found to have minimal adverse effect on the skin in terms of a mild epidermal shedding seen with other solvents in some sheep.

Alternatively, the formulation may be an aqueous formulation containing the pyrethroid in the form of a suspension or emulsion and comprising suitable surfactants to stabilise the suspension or emulsion, and prevent undue run-off from the back of the sheep. Thus, it has been surprisingly found that the pyrethroid is effective even when in the undissolved state.

Paraffin oils, vegetable oils, e.g. corn oil, peanut oil, castor oil, olive oil, can be added as viscosity modifiers and co-solvents.

Alkylamides and esters of fatty acids are useful formulation adjuncts e.g. n-butyl oleate, N,N-dimethyl oleamide and isopropyl myristate (IPM).

It has been found that the inclusion of an antioxidant such as 2,6-ditert-butyl-4-cresol (BHT) or 2-tert-butyl-4-methoxyphenol (BHA) has a useful stabilising effect on the active ingredients in formulations based on glycols, glycol ethers, glycol ether esters and cyclohexanone.

The present invention will now be illustrated with reference to comparative tests showing the lack of activity of a large number of conventional insecticides, and with reference to specific examples illustrating the present invention.

(I) Comparative tests

The effectiveness of a number of known insecticides in controlling sheep lice using pour-on formulations was assessed. A summary of the active agents and dose rates is given in Table 1.

TABLE 1

Chemical	Pour-on (mg/kg)
chlorfenvinphos	100
maldison	250
carbaryl	100
dimethoate	100
dioxathion	100
ethion	100
fenitrothion	100
trichlorphon	100
famphur	50, 100
ronnel	100
crotoxyphos	100
bendiocarb	100
bromophos ethyl	100
dichlofenthion	100
crufomate	100
naled	100

All the pour-on treatments were formulated in a solvent system containing xylene, cyclohexanone and corn oil.

A total of 18 groups of lice-infested merino sheep divided into control (1) and treatment groups (17) were selected and treated according to Table 1.

No pour-on treatment had any significant effect on existing lice burdens.

(II) Treatment according to the present invention

A variety of pyrethroids were evaluated in the control of lice and keds on merino sheep, when applied by a liquid pour-on formulation.

Test 1 (xylene-cyclohexanone-corn oil solvent)

Forty-eight merino sheep, half carrying full-wool and half carrying one month's wool, with significant louse infestations, were allocated equally into four groups of six animals.

Treatments, with formulations comprising a xylene (55 wt %), cyclohexanone (30 wt %), corn oil (15 wt %) solvent system were made as follows:

Group 1	deltamethrin	10 mg/kg	10 mg/ml formulation
Group 2	deltamethrin	50 mg/kg	50 mg/ml formulation
Group 3	permethrin	100 mg/kg	100 mg/ml formulation
Group 4	permethrin	250 mg/kg	250 mg/ml formulation.

On full-woolled sheep, partings were made along the backline to place the formulation at skin level. After treatment the various groups, each with three full-woolled and three short-woolled sheep, were held in separate pens, remote from each other.

Post-treatment lice examinations were made at 1, 3 and 7 weeks, to assess the effects of the various treatments on the louse populations

At seven weeks, groups 1 and 2 were run with a mob of fifteen infestor sheep, carrying considerabl lic inf stations, to gauge th persist nc of deltamethrin. Further examinations were made at 9 weeks but subsequ nt xaminations w r pr vented by w t weather.

Results

The results of the pre-treatment and post-treatment lice examinations are shown in Table 2 and are outlined below.

GROUP 1 deltamethrin (10 mg/kg)	full wool	Infestations fell rapidly to extremely low levels and persisted at these low levels throughout the trial.
	short wool	One light infestation was eradicated by Week 1. Moderate to heavy infestations were eradicated by Week 7.
GROUP 2 deltamethrin (50 mg/kg)	full wool	At one week, two newly emerged lice were found in matted wool on one animal, only after an exhaustive search. No lice were seen on the other two animals. At Week 3 an exhaustive search of each animal revealed one or two newly emerged lice. No lice were found at Week 7 or at Week 9, after a fourteen-day challenge period.
	short wool	No lice were seen at any examination after treatment.
GROUP 3 permethrin (100 mg/kg)	full wool	Infestations were markedly reduced but were maintained at low levels throughout the trial.
	short wool	Infestations were reduced to extremely low levels but lice were still present at Week 7.
GROUP 4 permethrin (250 mg/kg)	full wool	Infestations were greatly reduced on two out of three sheep but persisted at low levels until Week 7. Lice were eradicated on the third animal by Week 7.
	short wool	Light infestations were drastically reduced at Week 1 and eradicated at Week 3.

In the following tables, the numbers represent the total number of lice detected in twenty partings of the wool of the sheep, and

L = light infestation

M = moderate infestation

H = high infestation

0 = no lice present

\+ = lice present.

TABLE 2

(First Three Sheep per Group Carrying Full-Wool, Second Three Carrying One Month's Wool)

Group	Sheep No.	Pre-Treatment	Week 1	Week 3	Week 7	Week 9	Comments
GROUP 1 deltamethrin (10 mg/kg)	B 34	H	13/20	24/20	16/20	2/20	
	B 882	H	L–M	L–M	2/20*	8/20*	*One heavy patch found in neck fold
	O 800	L	0	0	0	0	
	B 28	M–H	14/20	0	0	0	
	Y 749	M–H	3/20	1/20	0	0	
GROUP 2 deltamethrin (50 mg/kg)	B 883	M–H	0	5/20	0	0	
	G 790	H	2/20**	1/20	0	0	
	Y 840	M–H	0	2/20	0	0	** Found in matted wool
	B 44	M–H	0	0	0	0	
	Y 830	L–M	0	0	0	0	
	Y 738	M	0	0	0	0	
GROUP 3 permethrin (100 mg/kg)	B 50	H	L	L	L		
	Y 835	H	M	M–H	M–H		
	Y 833	H	L	L	19/20		
	B 27	M–H	20/20	9/20	24/20		
	B 49	M	17/20	6/20	11/20		
	Y 744	L–M	7/20	3/20	4/20		
GROUP 4 permethrin	B 887	H	12//20	7/20	3/20		
	B 38	L–M	7/20	0	0		
	B 42	H	L–M	L–M	L		
	B 35	L	1/20	0	0		
	B 29	L	1/20	0	0		
	Y 991	L	1/20	0	0		
CONTROLS	47	L–M	M–H	M	L	L	
	877	H	H	H	H	H	
	742	H	H	H	M–H	M–H	
	754	L	L–M	L–M	L	L–M	
	37	M	M	L	L	L–M	
	736	L–M	M	L–M	died		

Test 2

The results of the evaluation of deltamethrin on recently sheared merino sheep using xylene and DGBE-based solvent systems are given in Tables 3 and 4. The results of the untreated control group are given in Table 5.

The xylene-based solvent system is the same as that given in Test 1.

The DGBE-based solvent system had a composition as follows:

diethylene glycol mono-n-butyl ether (DGBE)	85 wt%
isopropyl myristate (IPM)	15 wt%
2,6-ditert-butyl-4-cresol (BHT)	2.5 g/l.

TABLE 3

Xylene-Based Solvent*

Delta-methrin (g/l)	Group	Sheep No.	Body-weight (kg)	Dose (ml)	Post-Treatment Inspections week 3	Post-Treatment Inspections week 6	Challenge Inspections (Group 1 and Group 2) week 10	Challenge Inspections (Group 1 and Group 2) week 12	Challenge Inspections (Group 1 and Group 2) week 14
8.0	GROUP 1 (a)	51	50	6.3	0	0	0	0	1
	1 mg/kg	90	46	5.8	0	0	0	0	2
	1 ml/8 kg	106	44	5.5	0	0	0	0	0
4.0	GROUP 1 (b)	52	44	11.0	0	0	0	lambed	
	1 mg/kg	55	48	12.0	0	0	0	0	
	1 ml/4 kg	139	43	10.8	0	0	0	0	
16.0	GROUP 2 (a)	54	50	6.3	0	0	0	0	2
	2 mg/kg	112	44	5.5	0	0	0	0	1
	1 ml/8 kg	127	46	5.8	0	0	0	0	1
8.0	GROUP 2 (b)	53	44	11.0	0	0	slaughtered (injury)		
	2 mg/kg	88	48	12.0	0	0	0	1	3
	1 ml/4 kg	146	43	10.8	0	0	0	0	2
20.0	GROUP 3 (a)	76	50	6.3	0	0			
	2.5 mg/kg	126	44	5.5	0	0			
	1 ml/8 kg	134	46	5.8	0	0			
10.0	GROUP 3 (b)	67	44	11.0	0	0			
	2.5 mg/kg	75	42	10.5	0	0			
	1 ml/4 kg	102	48	12.0	0	0			
24.0	GROUP 4 (a)	113	50	6.3	0	0			
	3 mg/kg	131	44	5.5	0	0			
	1 ml/8 kg	137	46	5.8	0	0			
12.0	GROUP 4 (b)	69	44	11.0	0	0			
	3 mg/kg	84	42	10.5	0	0			
	1 ml/4 kg	143	48	12.0	0	0			
32.0	GROUP 5 (a)	61	49	6.1	0	0			
	4 mg/-g	141	44	5.5	0	0			
	1 ml/8 kg	147	46	5.8	0	0			
16.0	GROUP 5 (b)	71	44	11.0	0	0			
	4 mg/kg	110	42	10.5	0	0			
	1 ml/4 kg	118	47	11.8	0	0			
40.0	GROUP 6 (a)	58	45	5.6	0	0			
	6 mg/kg	68	49	6.1	0	0			
	1 ml/8 kg	83	43	5.4	0	0			
20.0	GROUP 6 (b)	80	44	11.0	0	0			
	5 mg/kg	124	47	11.8	0	0			
	1 ml/4 kg	125	42	10.5	0	0			

*Figures shown in "week" columns are the number of lice seen in twenty wool partings.

TABLE 4

DGBE-Based Solvent*

Delta-methrin (g/l)	Group	Sheep No.	Body-weight (kg)	Dose (ml)	Post-Treatment Inspections week 3	Post-Treatment Inspections week 6	Challenge Inspections (Group 1 and Group 2) week 10	Challenge Inspections (Group 1 and Group 2) week 12	Challenge Inspections (Group 1 and Group 2) week 14
	GROUP 1 (c)	60	45	5.6	0	0	0	1	1
8.0	1 mg/kg	73	49	6.1	0	0	0	3	0
	1 ml/8 kg	85	43	5.4	0	0	0	1	1
	GROUP 1 (d)	78	41	10.3	<1/20	0	0	4	1
4.0	1 mg/kg	81	44	11.0	0	0	1	0	1
	1 ml/4 kg	129	47	11.8	0	0	0	0	0
	GROUP 2 (c)	62	45	5.6	0	0	0	3	2
16.0	2 mg/kg	74	49	6.1	0	0	0	1	1
	1 ml//8 kg	96	43	5.4	0	0	slaughtered (injury)		
	GROUP 2 (d)	18	41	10.3	0	0	0	1	0
8.0	2 mg/kg	89	44	11.0	0	0	0	1	1
	1 ml/4 kg	132	47	11.8	0	0	0	1	2
	GROUP 3 (c)	86	49	6.1	<1/20	0			
20.0	2.5 mg/kg	107	45	5.6	0	0			
	1 ml/8 kg	114	43	5.4	0	0			
	GROUP 3 (d)	91	41	10.3	0	0			
10.0	2.5 mg/kg	94	44	11.0	0	0			
	1 ml/4 kg	144	47	11.8	0	0			
	GROUP 4 (c)	108	45	5.6	0	0			
24.0	3 mg/kg	117	43	5.4	0	0			
	1 ml/8 kg	120	49	6.1	0	0			
	GROUP 4 (d)	56	40	10.0	0	0			
12.0	3 mg/kg	57	46	11.5	0	0			
	1 ml/4 kg	97	44	11.0	0	0			
	GROUP 5 (c)	119	43	5.4	0	0			
32.0	4 mg/kg	128	49	6.1	0	0			
	1 ml/8 kg	135	45	5.6	0	0			
	GROUP 5 (d)	66	40	10.0	0	0			
16.0	4 mg/kg	70	46	11.5	0	0			
	1 ml/4 kg	98	44	11.0	0	0			
	GROUP 6 (c)	133	43	5.4	0	0			
40.0	5 mg/kg	136	49	6.1	0	0			
	1 ml/8 kg	145	45	5.6	0	0			
	GROUP 6 (d)	72	40	10.0	0	0			
20.0	5 mg/kg	87	46	11.5	0	0			
	1 ml/4 kg	101	44	11.0	0	0			

*Figures shown in "week" columns are the number of lice seen in twenty wool partings.

TABLE 5

Results of Examinations of Shorn Untreated Control Group*

Untreated Controls			
Sheep No.	Body-weight (kg)	Week 3	Week 6
65	51	10	10
77	56	9	8
79	52	17	15
82	38	24	31
95	54	18	29
104	28	37	35
105	52	20	8
111	29	24	23
116	44	10	16
122	39	22	18
123	36	19	18
130	35	18	17

*Figures show the number of lice seen in twenty wool partings.

Test 3 (varying solvent systems)

Table 6 gives the results for formulations of deltamethrin in a variety of other solvent systems when applied to recently sheared merino sheep.

TABLE 6

Various Solvent Systems

Sheep No.	Body wt (kg)	Dose (ml)	Pre-Treatment	Week 4	Week 6	Week 8	Formulations
140	27	6	91	0	0	0	10 g/l deltamethrin in xylene system of Test 1
174	27	6	66	0	0	0	
175	26	6	30	1	0	0	
172	17	9	47	1	0	0	10 g/l deltamethrin 2.5 g/l BHT to 1 litre with cyclohexanone containing 50 ppm SUDAN RED IV
178	33	8	90	0	0	0	
180	34	8	47	0	0	0	
131	25	6	51	0	0	0	10 g/l deltamethrin 2.5 g/l BHT 50 ppm SUDAN RED IV DGBE/cyclohexanone (65:35 w/w) to 1 litre
132	29	6	34	0	0	0	
138	28	6	87	0	0	0	
142	32	8	73	0	0	0	10 g/l deltamethrin 100 g/l mineral oil 2.5 g/l BHT 50 ppm SUDAN RED IV cyclohexanone to 1 litre
149	24	6	47	0	0	0	
181	31	8	27	0	0	0	
164	36	5	117	0	0	0	10 g/l deltamethrin 100 g/l mineral oil 2.5 g/l BHT 50 ppm SUDAN RED IV diethylene glycol mono-n-butylether (DGBE) to 1 litre
165	33	8	47	0	0	0	
177	30	4	27	0	0	0	
143	31	8	90	1	0	0	10 g/l deltamethrin 2.5 g/l BHT 50 ppm SUDAN RED IV dipropylene glycol monomethyl ether (DPM) to 1 litre
155	21	6	44	1	0	0	
162	25	6	75	1	0	0	
137	29	6	60	0	0	0	10 g/l deltamethrin 2.5 g/l BHT 100 g/l acetylated lanoline alcohols cyclohexanone to 1 litre
163	28	6	72	0	0	0	
169	21	6	39	0	0	0	

TABLE 6 (Continued)

Various Solvent Systems

Sheep No.	Body wt (kg)	Dose (ml)	Pre-Treat-ment	Week 4	Week 6	Week 8	Formulations
156	23	6	57	1	0	0	as for Example No. 10
176	31	8	180	2	0	0	
129	29	–	14	14	8	17	Controls
130	23	–	18	28	14	22	
154	25	–	–	171	47	72	
160	36	–	17	8	8	24	
171	30	–	17	29	24	20	

Test 4 (varying pyrethroids)

The efficacy of a variety of different pyrethroids applied as liquid pour-on formulations to merino sheep was determined. The results are given in Table 7. A backline application was made within 24 hours of shearing. All formulations used the xylene-based solvent system given in Test 1, except flumethrin which was formulated as a miscible oil formulation but which was diluted with the xylene-based solvent to achieve the lower concentrations.

The results show all the pyrethroids tested to be effective, although at the dosages used phenothrin and flumethrin did not give complete eradication.

Test 5 (effect of deltamethrin against keds)

The efficacy of deltamethrin against infestations of merino sheep with keds (Melophagus ovinus) was determined by applying 8 ml of deltamethrin in the xylene-based solvent system given in Test 1 as a backline treatment to twenty newly shorn sheep. Twenty further sheep were treated in the same way with deltamethrin in the DGBE-based solvent system given in Test 2. The concentration of deltamethrin was 10 g/l.

All forty sheep were re-examined 10 weeks after treatment and no live keds were found.

TABLE 7

Control of the Sheep-Biting Louse by a Number of Pyrethroids

Compound/Dose/! Formulation	Sheep No.	Result (No. of Lice)
CYPERMETHRIN		
5 mg/kg (1 ml/5 kg–25 g/l formulation)	782	0
	767	7
	732	26
50 mg/kg (1 ml/5 kg–250 g/l formulation)	756	0
	746	0
	733	0 (14/10 – D)
PHENOTHRIN		
25 mg/kg (1 ml/5 kg–125 g/l formulation)	721	8
	765	23
	727	3
400 mg/kg (4 ml/5 kg–500 g/l formulation)	724	8
	779	6
	753	18
FENVALERATE		
10 mg/kg (1 ml/5 kg–50 g/l formulation)	744	9
	740	3
	769	2 (14/10 – D)
100 mg/kg (2 ml/5 kg–250 g/l formulation)	766	0
	770	0
	730	0
FLUMETHRIN		
0.5 mg/kg (1 ml/5 kg–2.5 g/l formulation)	783	21
	725	10
	719	1
12–16 mg/kg (25 ml/30–40 kg – 20 g/l formulation)	722	0
	755	5
	748	7
CONTROLS no treatment	741	64
	737	52
	764	83
	754	53
	758	121
	723	55

D = died between 14/10 and 21/10.

Test 6 (time to take effect)

The time for the pyrethroid to fully clear the merino sheep following backline application of the liquid formulation was investigated and the results are shown in Table 8. These demonstrate that the pyrethroid takes a finite period to completely clear the sheep of lice. However, the sheep are substantially cleared within 15 days. The effect is also demonstrated in certain of the preceding Tables.

TABLE 8

Process of Reduction in Lice Numbers
Following Pyrethroid Backlin Treatment

Group	Sheep No.	Lice Score Day 0	7	9	15	35	42
Cypermethrin 50 mg/kg	756	>20	7	3	0	2I	0
	746	>20	7	2	5	21	0
	733	>20	9	3	0	0	0
Fenvalerate 100 mg/kg	766	>20	2	2	3	0	0
	770	>20	6	1	0	0	0
	730	>20	2	2	2	1I	0
Flumethrin 12–16 mg/kg	722	>20	10	—	8	4I	0
	755	>20	19	—	10	18I	3I,2A
	748	>20	12	—	4	7I,2A	4I,3A
Controls	741	>20	—	—	14	—	64(18)
	737	>20	—	—	15	—	52(18)
	767	>20	—	—	16	—	83(19)
	754	>20	—	—	10	—	53(15)
	758	>20	—	—	22	—	121(19)
	723	>20	—	—	20	—	55(13)

I = immature lice
A = adult lice

(III) Formulations for use according to the present invention

Suitable formulations are presented in the following Examples. In general, a suitable solvent system contains 0 to 100% by weight xylene, 0 to 100% by weight cylohexanone, and up to 20% by weight corn oil.

EXAMPLE 1

10.1 g of technical deltamethrin (989 g active per kg), was dissolved in a solvent consisting of:

cyclohexanone

Sudan Red IV (oil soluble dye) 50 ppm

and the volume adjusted to one litre to give a solution containing 10 g/l deltamethrin.

EXAMPLE 2

51 g of technical deltamethrin (989 g active constituent per kg) was dissolved in a solvent blend containing:

xylene	55% by weight
cyclohexanone	30% by weight
corn oil	15% by weight
Sudan R d IV	1000 ppm

and the volune adjusted to one litre with the same solvent blend to give a solution containing 50 g/l deltamethrin.

EXAMPLE 3

10.1 g of technical deltamethrin (989 g active per kg) was dissolved in a solvent blend, containing:

xylene	55% by weight
cyclohexanone	30% by weight
corn oil	15% by weight
Sudan Red IV	50 ppm

and the volume adjusted to one litre with the same solvent blend, to give a solution containing 10 g/l deltamethrin.

EXAMPLE 4

51 g of technical deltamethrin (989 g active per kg) was dissolved in the same solvent blend given in Example 3 and the volume adjusted to give a solution containing 50 g/l deltamethrin.

EXAMPLE 5

10.1 g of technical deltamethrin (989 g active per kg) was dissolved in a solvent consisting of:

diethylene glycol monobutyl ether	
BHT antioxidant	2500 ppm
Sudan Red IV	50 ppm

and the volume adjusted to one litre with the same solvent to give a solution containing 10 g/l deltamethrin.

EXAMPLE 6

10.1 g of technical deltamethrin (989 g active per kg) was dissolved in a solvent blend containing:

cyclohexanone	50% by weight
diethylene glycol monobutyl ether	50% by weight
BHT antioxidant	2500 ppm
Solvent Blue No. 36	50 ppm

and the volume adjusted with the same solvent blend to give a solution containing 10 g/l deltamethrin.

EXAMPLE 7

10.1 g of technical deltamethrin (989 g active per kg) was dissolved in a variety of solvent blends containing:

diethylene glycol monobutyl ether or ethylene glycol monobutyl ether acetate	85—90% by weight
isopropyl myristate	10—15% by weight
BHT antioxidant	2500 ppm
Sudan Red IV	50 ppm

and the volume adjusted with the respective solvent blend to give a solution containing 10 g/l deltamethrin.

EXAMPLE 8

Amounts of 2.6, 10.5, 42.5 and 84.2 g of technical cypermethrin (950 g active per kg) were dissolved in a solvent blend containing:

xylene	55% by weight
cycloh xanone	30% by weight
corn oil	15% by weight

and the volume adjusted to one litre with the same solvent blend to give solutions containing 2.5 g, 10 g, 40 g and 80 g per litre respectively of cypermethrin.

EXAMPLE 9

103 g of technical permethrin (970 g active per kg) in which the cis:trans isomer (arising from the two asymmetric carbon atoms in the cyclopropane ring) ratio was 25:75, was dissolved in a solvent blend containing:

xylene	55% by weight
cyclohexanone	30% by weight
corn oil	15% by weight

and the volume adjusted to one litre with the same solvent blend to give a solution containing 100 g/l permethrin.

EXAMPLE 10

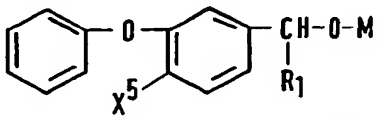
An aqueous suspension of deltamethrin was prepared by suspending 10.1 g of technical deltamethrin of average particle size 2 to 5 microns in an aqueous formulation containing:

non-ionic wetting agent { 1 mole nonylphenol condensed with 15 moles of ethylene oxide }	1.5 g
fumed silicon dioxide	5.0 g
xantham gum	4.0 g
propylene glycol	60.0 g
formaldehyde	1.0 g
silicone oil (antifoaming agent)	1.0 g
water	to one litre.

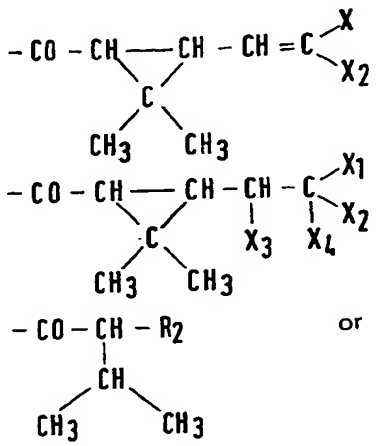
Various other deltamethrin suspensions in the range 1 to 500 g/l deltamethrin were also prepared.

CLAIMS

1. A method of controlling sheep ectoparasites which comprises the application onto a localised region of the skin or fleece of a sheep of a pyrethroid of the formula



wherein M is



or

and wherein

X_1 to X_4 are independently selected from halo, C_1—C_4 alkyl, halogen-substituted C_1—C_4 alkyl, and halogen-substituted phenyl;

X_5 is —H or halo;

R_1 is —H or cyano; and

R_2 is halogen-substituted phenyl.

2. A method according to claim 1 wherein the pyrethroid is selected from permethrin, phenothrin, deltamethrin, cypermethrin, cyhalothrin, flumethrin, cyfluthrin, cyphenothrin, tralomethrin, tralocythrin and fenvalerate (all as herein defined).

3. A method according to any preceding claim wherein the pyrethroid is applied to a substantially full-wooled sheep.

4. A method according to any preceding claim wherein the sheep is a merino sheep.

5. A method according to any preceding claim wherein the pyrethroid is applied at a rate of from 1 to 500 mg per kilogram sheep body weight.

6. A method according to any preceding claim wherein a pour-on application of from 2 to 15 ml of a liquid formulation comprising the pyrethroid is made.

7. A method according to any preceding claim wherein a liquid formulation is applied which comprises the pyrethroid dissolved in a solvent system comprising 30—70 wt % xylene, 20—40 wt % cyclohexanone and 5—25 wt % vegetable oil.

8. A method according to any one of claims 1 to 6 wherein a liquid formulation is applied which comprises the pyrethroid dissolved in a solvent system comprising a major proportion of diethylene glycol mono-n-butyl ether.

9. A method according to claim 8 wherein the solvent system further comprises a minor proportion of isopropyl myristate.

10. A method according to any one of claims 1 to 6 wherein a liquid formulation is applied which comprises a suspension or emulsion of the pyrethroid in an aqueous liquid.

11. A method according to any one of claims 1 to 5 wherein the pyrethroid is applied in the form of an aerosol.

12. A method according to any preceding claim wherein the sheep is infested with lice.

13. A method according to any preceding claim wherein the sheep is infested with keds.

14. A method of controlling sheep lice which comprises the application of a formulation substantially as disclosed in any Example.

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